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A PROCEDURE FOR PERFORMANCE ASSESSMENT OF DRUGS HYPOTHESIZED TO BE EFFECTIVE IN CONTROLLING MOTION SICKNESS

THESIS

Zainab N. Ahmed, Captain, USAF

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COMMITTEE:	NAME/DEPARTMENT	SIGNATURE
Advisor/co-Advisor *(circle appropriate role)*	Dr. Matthew Kabrisky	
co-Advisor/ENS Representative *(circle appropriate role)*	Major Thomas Kelso	
Reader	Major Steve Rogers	

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THESIS

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Zainab N. Ahmed, B.S. B.A.

Captain, USAF

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Acknowledgments

The purpose of this study was to develop a procedure for determining the performance effects of antimotion sickness drugs being tested by the Air Force Institute of Technology. The methods used by the psychological community for doing this type of testing are very lacking in standardization. Thus, it can be difficult for a drug to gain universal acknowledgement of its effectiveness, or lack thereof. One organization, the Office of Military Performance Assessment Technology (OMPAT), is beginning to standardize performance testing in the military through the use of the Unified Tri-Services Cognitive Performance Assessment Battery (UTC-PAB). It is this battery that I recommended for future AFIT drug testing.

When I began my thesis, I knew very little about motion sickness research, or the medicine behind it. I thank Dr. William Chelen for his help in this area and his ongoing critiques of my work from a medical/psychological standpoint. His involvement in AFIT research since 1985 made him a primary source of corporate knowledge. I am indebted to my faculty advisor, Dr. Matthew Kabrisky, for his wonderful method of positive reinforcement and for his reassurance at times of uncertainty. Major Steve Rogers' timely review of my drafts was invaluable for avoiding last-minute panic. I also wish to thank Major Thomas S. Kelso for his help and cooperation.

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Abstract

The Air Force Institute of Technology (AFIT) is conducting research into the effectiveness of certain drugs for controlling motion sickness. If the drugs are found to be useful, they must still be proven to have no harmful effects on the operator's performance abilities.

There are many methods for assessing performance effects of drugs but very little standardization exists. The Unified Tri-Services Cognitive Performance Assessment Battery (UTC-PAB) is a performance assessment method designed to be used by all the military branches. This will encourage standardization of drug testing, exchange of data, and comparability of methods. Five tests were chosen from the UTC-PAB menu to form the initial basis of AFIT drug performance testing. The selection of tests can also be tailored to meet future testing needs. The tests are 4 Choice Serial Reaction Time, Visual Memory Search, Mathematical Processing, Manikin, and the Unstable Tracking/Memory Search Dual Task. The UTC-PAB software/hardware is still in development , so these tests will be implemented from the software of the Walter Reed Performance Assessment Battery (WRPAB) and the Advisory Group for Aerospace Research and Development -Standardized Tests for Research with Environmental Stressors Battery (AGARD-STRES).

A PROCEDURE FOR PERFORMANCE ASSESSMENT OF DRUGS HYPOTHESIZED TO BE EFFECTIVE IN CONTROLLING MOTION SICKNESS

I. Introduction

Background

Motion sickness is believed to be caused by conflicting spatial orientation cues. It is a serious problem in the space program and all branches of the military. Personnel in the space and aerospace arenas have lost numerous productive hours trying to overcome the effects of motion sickness (13:1185; 27:773; 46:2; 51:1).

The academic and military communities have devoted considerable research time to solving the problem of motion sickness. Biofeedback, drug treatments, habituation, and cognitive-behavioral therapy are all common research paths (23:307). While in the process of developing a biofeedback system for teaching pilots to self-regulate their response to conflicting motion sensations, the research effort at the Air Force Institute of Technology (AFIT) took an unexpected sidetrack (8). In 1987, Dr. Matthew Kabrisky, Dr. William Chelen, and their team of AFIT graduate students noticed an unusual pattern in the subjects' electroencephalograms (EEGs). EEGs are an electrical measure of brain wave activity. When the subjects became motion sick, their low-frequency, high voltage EEGs were similar to those sometimes seen in partial epileptic seizures (8). The AFIT team decided to begin experimenting with drugs used to

control epileptic symptoms to determine if the drugs could also be used to control motion sickness.

Since that time, Chelen and Kabrisky have been pursuing the testing of the anticonvulsant drug phenytoin (trade name Dilantin) to measure its effect on motion sickness. They are also beginning to look into comparisons of phenytoin with other drugs. Such a comparison will determine if it is just phenytoin that works, or if any anticonvulsant drug has the necessary properties to control motion sickness. As the drug testing results continue to appear more and more promising, it has become imperative to assess the drugs' impact on user performance.

Justification

Regardless of how well phenytoin, or any other drug, may be found to prevent motion sickness, the drugs will not be accepted for use operationally if performance side effects prevent normal functioning in a space or aerospace environment.

Statement of the Problem

It is the purpose of this research activity to select and implement a performance assessment method to determine the side effects of drugs hypothesized to control motion sickness in a space or aerospace environment.

Methodology

Chapter II: Literature Review. This section is a literature review of performance assessment methods currently being used in antimotion sickness drug testing, phenytoin testing, and military performance testing. The experts at

the Air Force Human Systems Division (HSD) are well acquainted with the need to identify the side effects of drugs and the details of accomplishing such research. A number of HSD psychologists are stationed at Wright-Patterson AFB with the Harry G. Armstrong Aerospace Medical Research Laboratories (AAMRL). Interviewing these researchers provided a fundamental list of available procedures, as well as military points of contact for further information. The intent of Chapter Two was to find any possible standardization existing in these areas of performance assessment, or at least find some methods that are more commonly used than others. This ensured that no time was spent duplicating prior research efforts or creating procedures and experimental methods that already existed.

Chapter III: Performance Assessment Procedures. This section is a description of how AFIT currently tests the performance effects of drugs that may have efficacy in fighting motion sickness. It details which test battery is in use and the subset of tests being run. The chapter also describes the overall procedure for measuring the volunteers' subjective side effects.

Chapter IV: Analysis. This section presents the selection and justification of an updated method of performance assessment. The literature review produced an assortment of performance tests used to evaluate antimotion sickness drugs. Whether those tests stemmed from phenytoin research, antimotion sickness drug research, or military performance assessment, it was a body of precedent to choose from. There were two options -- to use a performance battery or to proceed with a single operational emulation task. Since a performance battery was selected (for reasons explained in this chapter), the next step was to determine which tests in the battery were most appropriate for AFIT research.

A great deal of the decision criteria had to be specific to the AFIT motion sickness research effort. The tests needed to be sensitive to effects the current procedure is not quantifying, yet they had to be within the mainstream of military performance testing. In addition, research subjects can only be expected to provide a limited amount of their time. Therefore, time constraints affected the choice of batteries and number of tests to be run. Since most of the future graduate students performing the research will have no background in performance testing, the test procedure also had to be as straightforward and as automated as possible.

Chapter V: Implementation. This chapter recommends changes to the overall current performance assessment procedure. The changes include moving equipment locations and using written and computerized questionnaires to capture subjective feelings of side effects. This section also describes what software/hardware will be necessary for the new procedure, and how to go about implementing the new performance batteries.

Chapter VI: Recommendations and Conclusions. The conclusions section suggests areas for future research and discusses why the new performance assessment approach is beneficial to the overall AFIT motion sickness research effort.

Scope

This research activity proposes a method for isolating performance side effects of antimotion sickness drugs. It is not intended to find only those side effects related to space flight, fixed-wing flying, or helicopter flying. Those kind of mission-specific side effects are left for future research efforts to identify.

II. Literature Review

Introduction

An initial examination of the literature uncovered a far less organized picture than the one hoped for, reflecting a total lack of standardization in drug performance testing. A large number of performance batteries are intended to be comprehensive but, in fact, are not universally accepted for testing use. In order to select a performance battery for use in the motion sickness research, it was necessary to examine the previous work on performance assessment. This review covered this earlier work in the following three parts: performance assessment across antimotion sickness drugs, phenytoin performance assessment, and military performance assessment.

First, the performance tests used in previous experimental work with specific antimotion sickness drugs was researched. The drugs AFIT is testing will eventually be compared against other antimotion sickness (AMS) drugs. Those AMS drugs have been tested for effectiveness and side effects. The new drugs under research at AFIT could have been tested using those same methods, if a standard method could have been found. Secondly, phenytoin, one of the drugs being tested by AFIT, is not uncommon. There is an extensive history of phenytoin testing and research. The second portion of the literature review examined if any of these phenytoin testing methods could also be used to look for motion sickness efficacy and performance side effects. Though little standardization was found, it was obvious that a number of tests used in other AMS drug testing are also used in phenytoin testing. Finally, the military has had to evaluate a number of drugs for operational use. A look at the performance

assessment batteries used in the military did find four procedures for military performance assessment.

Discussion

Performance Assessment Across Drugs. Any drug newly discovered to be effective in the effort to combat motion sickness will be compared to existing motion sickness remedies. Thus, an examination of how the AMS drugs in current use are evaluated for harmful side effects provided insight into possible performance testing methods for the AFIT drugs. Standardization of testing methods has the obvious benefit of making comparisons between drug evaluations much easier.

Among the drugs currently used to treat motion sickness, there is a certain group used more commonly than the rest, and generally accepted to be more effective. In a number of studies that compared motion sickness drugs to each other, in terms of the time required for the subject to experience a certain level of motion sickness, the drugs most commonly studied were scopolamine, dimenhydrinate (dramamine), d-amphetamine, cyclizine (marezine), meclizine (bonine, antivert) and promethazine (phenergan) (12:348; 26:1109; 27:775; 78:1343). Scopolamine is generally thought to be the most effective remedy for motion sickness (12:345; 82:1). Dimenhydrinate is in the class of antihistamines, which are readily available to the public (38:615). However, antihistamines are less effective for preventing motion sickness onset or its development than the stronger anticholinergics (drugs that block the neurotransmitter acetylcholine). The anticholinergics, like scopolamine, also have more noticeable side effects (38:615).

Table 1 displays the conditions of a representative sample of experimental studies done on the effectiveness of (AMS) drugs. The table does not summarize the results of those experiments, but rather notes the wide variety of methods used to detect performance decrements or side effects caused by the AMS drugs. A table format is used to shorten the summary and so the many different testing methods may be clearly visible and contrasted.

Table 1: Performance Assessment Across AMS Drugs

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Brand and Colquhoun (3) 1968	Effect of varying dosages on Saliva Flow, Pulse Rate, Accommodative Power, and Mental Performance	1-Hyoscine (Scopolamine) and Cyclizine	Vigilance Test, Speed of Arithmetical Computation, Salivation Test, Visual Acuity, Pulse Rate Test	None
Callaway (6) 1984	Human Information Processing	Methylphenidate and Scopolamine	Reaction Time, P3 Latency	None
Callaway and Halliday (5) 1985	Human Stimulus Evaluation	Oral Scopolamine	Stimulus Evaluation Response Selection Task, Sine Wave Grating Sensitivity and Discrimination Task, Memory Scanning, Automated Space of Apprehension, Rapid Execution of Sequences	None

Table 1(Cont)

Author(s), Reference,. and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Collins and Schroeder (9) 1982	Nystagmic Response to Angular Accelerations and to Optokinetic Stimuli	Dimenhydrinate, Promethazine, D-amphetamine, in varying dosages, and combinations	Visual Field Fixation During Motion	None
Glaser (20) 1952	Producing Side Effects	l-hyoscine-hydrobromide, promethazine-hydrochloride, di-phenhydramine hydrochloride	None	Unnamed question-naires
Gordon and Binah (23) 1986	Performance	Transdermal Scopolamine	Vigilance Tests, Tracking Tests, Morse Test, Navigation Plotting, Code Substitution, Number Comparison, Arithmetic Test, Visual Search, and Auditory Digit Span, Visual Acuity, Salivation Test Some tests taken from the Performance Evaluation Tests for Environmental Research (PETER)	Unnamed question-naire and Depression Adjective Checklist

Table 1 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Gray and Cheung (24) 1983	Effectiveness of AMS Drug Combinations	Scopolamine, Promethazine, Ephedrine, Dexadrine, and combinations	Memory Test, Video Game Performance Logical Reasoning, Time Estimation, Flight Simulator Piloting Performance	Verbal Report
Graybiel and Cramer (25) 1982	MS 12 and 72 Hours after Drug Administration	Transdermal Scopolamine	None	Noted but no method given
Graybiel and Wood (26) 1975	Preventing MS	Scopolamine, Dimenhydrinate, D-amphetamine, Sulfate, Promethazine, etc.	None	Verbal
Homick and Kohl (32) 1983	Prevention of Motion Sickness By Varying the Time Administration of Drug	Transdermal Scopolamine	None	Side effects reported verbally and recorded
Hordinsky (33) 1982	Effectiveness of Proposed Space Transportation System AMS	Transdermal Scopolamine, Promethazine, Ephedrine Dextro-amphetamine, and combinations	Weight Discrimination , Finger Dexterity Test, Steadiness Test, Tapping Test, Tremor Measurement , Concentration Test	Verbal questions and Mood-related adjective selection
How (35) 1988	Prevention of Motion Sickness	Transdermal Scopolamine	None	Visual Analogue Scale , and written record

Table 1 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Kennedy and Openheimer (38) 1990	Microcomputer-Based Performance Tests	Scopolamine Amphetamine	Tapping, Air Combat Maneuvering, Pattern Comparison, Grammatical Reasoning, Code Substitution, Manikin, and Sternberg Task Tests from Automated Performance Test System (APTS)	None
Kennedy and Wood (37) 1966	Side Effects of AMS as Measured by Psychomotor Tests and Questionnaires	Hyoscine, Meclizine, D-amphetamine, Trimetho-benzamide, Chlopromazine, Thiethylperazine and combinations	Hand Steadiness Test, Reaction Time Task, Fitts Tracker Test, Flicker Fusion, Harvard Step Test, Graybiel-Fregley Posture Test, Hand Dynamometer, Spoke Test, IQ Test, Time Estimation , Visual Field, and Audiometric Methods	Unnamed side effect question-naire

Table 1 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Kohl and Calkins (40) 1986	Prevention of Space Motion Sickness	Sympathom-imetic Drugs (drugs used to counteract the side effects of other AMS drugs) Pemoline, Meth-amphetamine, Phenmetrazine, Phentermine, Methylphenidate	None	Reported side effects to test directors verbally
Mackay and Ferguson (41) 1951	Cerebral Function	Dimenhydrinate, Tripellanamine-HCl, Hyoscine HBr, and combinations- Vasano and R.C.N.	RAF S.M.A. III Complex Coordination Task, RCAF Rapid Calculation Test R.277	Verbal
Parrott (53) 1987	Effects of Single and Repeated Doses upon Psychological Performance	Transdermal Scopolamine	4-Choice Reaction Time, Letter Cancellation, Logical Reasoning, Target Tracking, Code Substitution, Rapid Visual Information Processing, Memory Task, Resting Heart Rate, Visual Assessments	Self-Rated Feeling States Side Effects Question-naire and Leeds Sleep Evaluation Question-naire

Table 1 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Parrott (52) 1986	The Effects of Varying Dosage Levels on Psychological Performance	Transdermal Scopolamine, Oral Scopolamine	Memory Storage, Rapid Visual Information Processing, 4-Choice Continuous Reaction Time Test, Cognitive Information Tasks, Discrete Choice Reaction Time, Critical Flicker Fusion, Target Tracking, Resting Heart Rate	Bipolar Visual Analogue Scale and yes/no side effect questions
Parrott and Jones (50) 1985	Psychological Test Performance at Sea	Transdermal Scopolamine	Letter Cancellation, Code Substitution, Reaction Time Test,	Subjective self-report on series of questions
Price and Schmitt (58) 1981	Prevention of MS at Sea	Transdermal Scopolamine	None	Verbal report
Schmedtje and Oman (65) 1988	Performance in an Operational Environment	Scopolamine, Dextro-amphetamine	Symbol-Digit Substitution, Simple Reaction Time, Pattern Recognition, Digit Span Memory, Pattern Memory Tests from Neurobehavioral Evaluation System	None

Table 1 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Performance Tests Used to Look for Side Effects of Drug Use	Method of Reporting Side Effects
Schroeder (66) 1985	Static and Dynamic Tracking Performance	Dimenhydrinate, Promethazine, and combinations	Tracking Task -- Static and Dynamic Conditions	Composite Mood Adjective Checklist
Stott and Hubble (72) 1985	Induced Motion Sickness	Powdered Ginger Root, Hyosine, Hydrobromide, Cinnarizine	Saccade Measurement, Ocular Accommodation, Missing Digit, Critical Flicker Frequency, Digit Symbol	Subjective estimation of alertness
van Marion (76) 1985	Motion Sickness During 7 days' Exposure to Heavy Seas	Transdermal Scopolamine	Bourdon-Wiersma Information Processing Task	Visual Analog Scale
Wood and Graybiel (78) 1968	Reducing Motion Sickness Susceptibility	16 AMS Drugs	None	Noted but method unknown
Wood and Graybiel (77) 1972	Preventing MS	Approx 20 AMS Drugs in Varying Combinations and Dosages	Response Analysis Tester (RATER) and Logical Interference Test (LOGIT)	None
Wood and Manno (80) 1984	Operational Proficiency due to Side Effects of AMS Drugs	Scopolamine, Promethazine, D-amphetamine, and combinations	Pursuit Meter	Cornell Medical Index
Wood and Manno (81) 1985	Performance Due to AMS Drug Side Effects	D-amphetamine, Promethazine, Marezine, Meclizine, Dimenhydrinate, and combinations	Pursuit Meter	Cornell Medical Index
Wood and Stewart (79) 1990	Secondary Symptoms of MS	Dimenhydrinate, Ephedrine, Scopolamine	Pursuit Meter	Cornell Medical Index

As seen in the table, some researchers concentrated on the medical efficacy of the drugs in combating motion sickness. Thus, those experiments looked for performance effects as a secondary objective. In such cases, side effects were often noted only verbally.

The experimenters tested performance with either a performance battery or a single test emulating an operational or real-life task. The real-life emulation assumes that if any one of the performance abilities the subject needs to act with has been severely affected, he/she will be unable to perform the operational task without some decrement. The Pursuit Meter is such a task. The Pursuit Meter that was used in some of the studies in Table 1 measures a person's ability to keep two displays superimposed (79:158). Its selection as a performance testing method was often attributed to its usefulness in measuring driving and flying abilities under varying stressors (18:259; 54:4; 80:113; 81:315).

On the other hand, there were a large number of experiments in which testing was done by performance battery. A performance battery is a group of tests designed to examine the different components of human performance. The tests are usually housed in menus from which tests appropriate to that application are then selected. Each test represents some aspect of overall performance, and a final decision on whether performance has been affected comes from the results of all the tests put together. Performance batteries can be used to test performance in a wide range of situations, not just drug testing. So, within each battery, a subset of tests applicable to the specific experiment was chosen. Though many of the researchers selected differently named batteries, a number of the tests within them looked essentially the same. Table 1 shows the repeated appearance of such tests as Code Substitution, Reaction

Time, Vigilance Tests, Arithmetic Tests, and Digit Span. This indicates that despite the different historical origins of the various batteries and the lack of standardization in the field, there are small subsets of tests within the batteries that are used commonly in AMS drugs performance testing.

Phenytoin Performance Assessment. The drug currently under examination for effectiveness at preventing or overcoming motion sickness at the Air Force Institute of Technology is phenytoin. Every drug must undergo a certain degree of testing to ensure it has no harmful side effects. Appendix A lists side effects of phenytoin and some common (AMS) drugs.

Phenytoin has been in use as an anticonvulsant for over 50 years and its specific side effects are known (4:151). Users of phenytoin are most specifically prone to the dose-related side effects (usually occurring at blood levels exceeding 20 mcg/ml) of drowsiness, vertigo, lightheadedness, unsteadiness, and speech slurring (42:1141). Though an anticonvulsant as well known and widely used as phenytoin has documented side effects, research is still being conducted on the drug. Table 2 is a representative look at some of this phenytoin research.

Table 2: Performance Assessment of Phenytoin Side Effects

Author(s), Reference, and Year	Study Tests the Effects of the Drug(s) on	Drug(s) Under Study	Tests or Evaluations Used to Measure Performance Side Effects	Method of Reporting Side Effects
Andrewes and Bullen (1) 1986	Cognitive Effects in Epileptic Patients	Phenytoin, Carbamazepine	Memory Scanning, Word List, Prose Memory, Decision Making, Tracking Task	Mood Adjective Checklist

Table 2 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Tests or Evaluations Used to Measure Performance Side Effects	Method of Reporting Side Effects
Booker and Matthews (2) 1967	Selected Physiological and Psychological Measures in Normal Adults	Phenytoin	Maze Coordination, Vertical GrooveTest, Horizontal Groove Test, Resting Steadiness Test, Static ReadinessTest, Grooved Pegboard Test, Sandpaper Roughness Discrimination Test, Seashore Measures of Musical Talent	None
Case (7) 1969	Neurotic Anxiety	Phenytoin	Psychiatric Evaluation	Physician Question-naire
Dodrill and Temkin (14) 1988	Motor Speed in Evaluating Cognitive Effects of Drug	Phenytoin	Reitan/Halstead Neuro-psychological Battery and Marching Test from the Reitan-Indiana Children's Neuro-psychological Battery	None

Table 2 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Tests or Evaluations Used to Measure Performance Side Effects	Method of Reporting Side Effects
Gallassi and Morreale (19) 1988	Cognitive Effects in Epileptic Patients During Monotherapy and Withdrawal	Carbamazepine, Phenytoin	Raven's Progressive Matrices, Simple Auditory Reaction Time, Complex Auditory Reaction Time Verbal Digit Span, Spatial Span, Verbal Learning Test, Spatial Learning, Finger Tapping Test, Trail Making Test, Fingertip Number Writing	None
Goldberg and Kurland (22) 1970	Social, Emotional, and Cognitive Behavior of Mentally Retarded Children	Phenytoin	Direct Psychological Assessment	None
Haward (28) 1973	Concentration in Pilots	Phenytoin	Following a Flight Plan and a Tracking Task	None
Haward (29) 1970	Concentration	Phenytoin, and Pemoline	Simulated Air Traffic Control Situation	None

Table 2 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Tests or Evaluations Used to Measure Performance Side Effects	Method of Reporting Side Effects
Houghton (34) 1972	Side Effects	Phenytoin, Phenobarbitone	Critical Flicker Fusion Threshold Task	None
Matthews and Harley (43) 1975	Side Effects in Varying Dosages	Phenytoin, Mysoline, Phenobarbital	Wechsler Adult Intelligence Scale, Halstead Category Test, Verbal Concept Attainment Test, Speech Perception Test, Seashore Rhythm, Trail Making, Knox Cuber, Fingertip Number Writing, Sandpaper Roughness Discrimination, Tactile Form Discrimination, Finger Tapping, Groove Pegboard, Maze Coordinate Static Steadiness	None
Meador (44) 1990	Cognitive Effects in Epileptic Patients	Carbamazepine, Phenobarbital, Phenytoin	Digit Span, Selective Reminding Test, Digit Symbol, Finger Tapping, Grooved Pegboard, Choice Reaction Time	Profile of Mood States

Table 2 (Cont)

Author(s), Reference, and Year	Study Tests the Effects of the AMS Drug(s) on	Drug(s) Under Study	Tests or Evaluations Used to Measure Performance Side Effects	Method of Reporting Side Effects
Smith and Lowrey (69) 1972	Cognitive Functions in Man	Phenytoin	Verbal Symbolic, Visual Spatial, Digit Symbol, Picture Completion, and Arrangement, IQ Tests, Digit Span, Information Test, Comprehension, Similarities Test, Block Design (Wechsler Adult Intelligence Tests)	None
Smith and Lowrey (70) 1975	Mental Abilities in Elderly	Phenytoin	Information Test, Comprehension, Digit Symbol, Block Design, Similarities Test, Picture Arrangement and Completion, General IQ Tests, Arithmetic Test, Digit Span (Wechsler Adult Intelligence Scale)	None

It is hard to make direct comparisons of many of these experiments given the wide differences in performance tests or questionnaires used. Due to these

differences in methodology, it can be difficult to determine if experimental results truly differed or were influenced by the different tests chosen.

The conclusions from the literature review on phenytoin testing are much the same as those for the review of performance testing of AMS drugs. Again, some researchers prefer simulating real-world tasks, but others are advocates of direct psychological assessment, Wechsler Intelligence Scales, or various performance batteries.

Even though many of the studies in Table 2 dealt with long-term phenytoin therapy, there was still some overlap with AMS performance testing (in terms of the tests chosen by those researching phenytoin). A few experiments were done with one identifiable battery but most were a combination from various batteries. As the table shows, Digit Span, Reaction Time, Vigilance Tests, and Finger Tapping appear frequently. A number of these are the same as those used in performance assessment of AMS drugs.

Military Performance Assessment.

The military is in the unique position of requiring an understanding of the operational side effects of a drug. Military drug performance testing demonstrates the same lack-of-standardization problems illustrated by Tables 1 and 2 (31). Getting agreement on the deleterious effects of a drug when used in an operational environment is extremely difficult without the basic requirement of comparability between experiments.

In an effort to overcome the data exchange problem, the military has begun standardizing performance testing. The literature review found four performance batteries that have histories of trying to promote standardization within the performance testing communities.

Table 3: Military Performance Assessment Batteries

Performance Battery and References	Origins and Uses	Performance Tests Included	
(CTS) Criterion Task Set (64)	Air Force developed by Harry G. Armstrong Aerospace Medical Research Laboratory , Wright-Patterson AFB OH Used as workload assessment technique Currently in use at AFIT for Motion Sickness research	1. Continuous Recall 2. Grammatical Reasoning 3. Interval Production 4. Linguistic Processing 5. Mathe-matical Processing	6. Memory Search 7. Probability Monitoring 8. Spatial Processing 9. Unstable Tracking
(AGARD-STRES) Advisory Group for Aerospace Research and Development - Standardized Tests for Research with Environmental Stressors (36)	Developed by a NATO Working Group to standardize performance testing, provide software/hardware independent test specifications, and facilitate global data exchange Uses: a. Sleep Loss b. Fatigue c. Monotony d. Boredom e. Illness f. Toxic Fumes g. Hypoxia h. Alcohol i. Other Drugs	1. Reaction Time 2. Mathe-matical Processing 3. Memory Search 4. Spatial Processing	5. Unstable Tracking 6. Grammatical Reasoning 7. Dual-Task Performance

Table 3 (Cont)

Performance Battery and Reference	Origins and Uses	Performance Tests Included	
(WRPAB) Walter Reed Performance Assessment Battery (48; 73)	Developed by US Army--Department of Behavioral Biology, Division of Neuropsychiatry, Walter Reed Army Institute of Research Intended to evaluate "performance changes over time, treatment, dosages or levels" Uses: 1. Sleep deprivation 2. Sustained performance 3. Jet lag 4. Heat stress 5. Physical fatigue 6. Physical conditioning 7. Effects of Atropine 8. Hypoxia 9. Sickle cell disorders	1. Choice Reaction Time 2. Time Estimation 3. Visual Search 4. Pattern Recognition 5. Sustained Attention 6. Short-Term Memory 7. Mental Arithmetic	8. Logical Reasoning 9. Self-Assessment 10. Manikin 11. Interval Production 12. Stroop Test 13. Code Substitution 14. Delayed Recall 15. Matching to Sample 16. 10-Choice Reaction Time

Table 3 (Cont)

Performance Battery and Reference	Origins and Uses	Performance Tests Included	
UTC-PAB Unified Tri-Services Cognitive Performance Assessment Battery (56)	Office of Military Performance Assessment Technology Intended as an instrument of assessment of cognitive performance in a multiple drug evaluation program selected by the Tri-Service Joint Working Group on Drug Dependent Degradation of Military Performance Used in drug testing	1. Linguistic Processing 2. Grammatical Reasoning (Traditional) 3. Grammatical Reasoning (Symbolic) 4. 2-Column Addition 5. Mathe-matical Processing 6. Continuous Recognition 7. 4-Choice Serial Reaction Time 8. Alpha-numeric Visual Vigilance 9. Memory Search 10. Spatial Processing 11. Matrix Rotation	12. Manikin 13. Pattern Comparison (Simultaneous) 14. Pattern Comparison (Successive) 15. Visual Scanning 16. Code Substitution 17. Probability Monitoring 18. Time Wall 19. Interval Production 20. Stroop Test 21. Dichotic Listening 22. Unstable Tracking 23. Sternberg-Tracking Combination 24. Matching to Sample 25. Item-Order

III. Current Performance Assessment Procedure

Air Force Institute of Technology (AFIT) use of a performance assessment battery to measure the cognitive and performance side effects of antimotion sickness drugs began in 1988. At the time, the drug phenytoin was under double-blind, crossover study.

In 1988, Morales and Scott incorporated the Criterion Task Set (CTS) into their experimental procedure (47:38; 67:15). The CTS, developed by the Air Force Medical Research Laboratory (AAMRL), is a battery of tests designed to evaluate human performance (68:6). In order to uncover any performance decrements caused by the use of phenytoin, the researchers began testing subjects with three tests selected from the CTS menu (47:39). They are still in use.

Table 4:CTS Tests Used in Initial Performance Testing(64:4-5;68)

Test	Use	Description	Data Gathered
Unstable Tracking	To test input/output through visual perception and manual response speed/accuracy	Subject attempts to center a jittering arrow on a center line	Reaction time and edge violations
Probability Monitoring	To test perception of visual input	Subject watches an arrow oscillating horizontally across a scale and identifies when the arrow stays predominantly in one area	Reaction time false positives missed signals number correct
Grammatical Reasoning (symbolic)	To test central processing through reasoning ability	Subject decides if symbols presented follow logic rules also presented	Number correct reaction time

Another CTS test, Memory Search, was later added to the performance battery (8). Memory Search is a task in which the subject must identify whether the prompt item was included in the earlier set of items presented to the subject.

At the beginning of the overall experiment, the subject undergoes a screening process that includes medical history, physical exam, blood tests, subject consent, and a motion susceptibility trial. Next, the subject completes an initial baseline performance assessment testing session. The CTS tests are administered on a Commodore 64 personal computer in the general laboratory area. The subject may practice any test as many times as he feels is necessary, but must do a minimum of six practice trials to reduce the effects of the learning curve.

At the start of each experimental session, the subject verbally reports any noted side effects of the placebo or medication. A physician notes the side effects in his research log and gives the subject a brief physical exam to note any disturbances caused by drug side effects. Then, whether the subject is on the placebo or the drug, another CTS battery is run. A researcher loads the CTS disk into the drive and initializes the system for the subject. If it has been over a week since the subject did his initial baseline CTS session, he is allowed one practice trial on each test. The subject then takes the tests in any order with any reasonable break between tests. Each test is three minutes in duration. The subject saves both the raw data and the statistics from each test. The CTS package automatically runs basic statistics on the data (see Table 5). One trial is run of each test.

IV. Analysis

Reason for Changing from Current Testing Procedure

One of the reasons for suggesting improvements to the current testing methodology used by the Air Force Institute of Technology (AFIT) is a discrepancy between the level of subjective symptoms being reported by volunteers and the lack of significant changes in their performance on the test battery. This suggests that tests of greater sensitivity may be needed.

Table 5: Performance Test Data Analysis

Researcher	Criterion Task Set (CTS) Test	Statistical Test or Data Collected	Results From Placebo to Phenytoin
Morales (47:61-65)	Probability Monitoring	Test stat t=-.5669 alpha = .01, DF =6 P(| z| > t) =.5913	**No significant difference**
	Grammatical Reasoning	Test stat t=-.9101 alpha = .01, DF=6 P(| z| > t)=.3979	**No significant difference**
	Unstable Tracking	Test stat t= .5664 alpha =.01. DF = 6 P(| z| > t) = .5916	**No significant difference**
Scott (67:53-55)	Probability Monitoring	Average number correct Average number false Average number misses biases Average Mean Response Time = MRT (sec)	Placebo: 9.8 correct, 3.9 false, 0 missed biases, MRT= 2.9 Phenytoin: 9.7 correct, 5.9 false, 0.3 misses biases, MRT=3.3. [sic] **No significant difference**

Table 5 (Cont)

Scott (cont) (67:53-55)	Grammatical Reasoning	Average Mean Correct Response Time = MCRT (msec) and Average Percentage correct	Placebo: MCRT = 3498.963, 95.27% correct Phenytoin: MCRT= 3263.366, 95.18 % correct **No significant difference**
	Unstable Tracking	Average Root Mean Square *(rms) Error* and Total Edge Violations	Placebo: 40.6 rms error and 48.6 edge violations Phenytoin: 42.5 rms error and 70.0 edge violations **No significant difference**

As shown above, Scott found no significant differences in the performance abilities of the subjects. Yet, Table 6 shows the side effects reported by the same subjects.

Table 6:Subject Symptoms Before Spin Test, on Phenytoin(67:56)

Subjects	Symptoms
1	Lightheadedness, apathy, constant muffled hearing
2	Diarrhea, gas (Subject thought due to diet)
3	Diarrhea, gas
4	No symptoms reported
5	Skin rash, lack of coordination, swollen tongue (Subject had history of drug allergies)
6	Subject never took Phenytoin [sic]
7	Lightheadedness, apathy, intermittent muffled hearing, *indecisiveness, drowsiness, indigestion*
8	Fatigue
9	Lightheadedness; become dizzy after tilting head back and after running (lightheadedness may be due to sinus infection)
10	Lightheadedness
11	Fatigue (subject reported that he was spending a lot of time in the evenings working on his thesis)

Despite the side effects the subjects reported, it is entirely possible that the effects of the drugs were insufficient to produce any performance effects. The reported symptoms are in keeping with the known side effects of phenytoin (see Appendix A). However, almost all of the subjects reported some sort of effects, even though none of the performance tests picked up a deficit. This result indicates that the tests may lack sensitivity. The testing procedure might also need to be supplemented with additional measures.

AFIT Performance Testing Requirements

The drugs being tested by AFIT for use in fighting motion sickness are to be used in an operational environment. Thus, the method of performance assessment that is selected must meet certain requirements. The testing method must be sensitive enough to pick up performance decrements that are unacceptable when the operator is in an operational environment. The testing method must also have some history of use in standard antimotion sickness drug research. The tests must have theoretical validity and a history of testing reliability. Finally, the testing method must have some apparent relevance to operational skills used in a military setting.

Suggested Procedure - Operational Task vs. Performance Battery

As shown in the literature review, there are two ways of approaching performance testing. The first option is the use of a real-life task approximation. The most frequently used operational task in drug performance testing is the use of the Pursuit Meter (see Tables 1 and 2). The second option is the use of a performance battery to look for cognitive/performance decrements.

The Pursuit Meter is a computer-based method of testing human tracking performance. A wave is displayed in one color that the subject must follow with a joystick, tracing his own wave in a separate color and attempting to superimpose his wave on the original (79:158). A number of different wave patterns are displayed and total tracing errors are recorded. The test is used by a number of motion sickness researchers and is thought to display "high sensitivity, sufficient duration, and good operational correlation" (81:310).

Despite the claims for the operational closeness of a tracking task, it is still only one task. A performance battery is intended to examine simple tasks as well as complex tasks, and isolate different effects. If a decrement in performance shows up on the Pursuit Meter, it is impossible to tell if the degradation has occurred in mental acuity, judgement, motor control, or any number of other factors (38:616). The performance battery has the advantage of not "putting all the testing eggs in one basket." If a particular task is not able to pick up the degradation in a mental or performance skill, another test may be more sensitive to it. A number of performance batteries include tracking tasks to try to find a middle ground -- to administer a task with high operational correlation, without making it the only test used.

If a drug that combats motion sickness is to be used in a military environment, it is imperative to know of any side effects of such a drug. Picking one operational task as the only measure of performance decrement relies too heavily on the sensitivity of that test. No test is perfect and no test can uncover all side effects. For that reason, the best choice is the one that leaves the most options open. Since a performance battery tests many different levels of functioning, it increases the opportunities for drug side effects to show up on a

subset of these tests. For the purposes of AFIT motion sickness drug research, the performance battery is the better option.

Performance Battery Selection

Once the decision was made to use a performance battery instead of an operational task, the next step was to select a battery. As shown in Tables 1 and 2, there are many different performance batteries used in the motion sickness research community. However, there was no universally accepted battery.

Since no civilian testing procedure stood out, there was no reason not to go with a battery used primarily in military circles. Table 3 describes four military performance testing batteries that could be used in AFIT motion sickness research. Table 7 shows some of the their advantages and disadvantages.

Table 7: Comparison of Military Performance Batteries

Battery and Reference	Advantages for AFIT use	Disadvantages for AFIT Use
CTS Criterion Task Set (64)	1. Developed at Wright-Patterson so user support available 2. Varying difficulty levels 3. Already in use at AFIT	1. Data must be hand-loaded or transferred through mainframe from Commodore 2. No dual task and split attention capability 3. Small test selection 4. Not widely used 5. No history of use in motion sickness research

Table 7 (Cont)

Battery and Reference	Advantages for AFIT use	Disadvantages
AGARD-STRES Advisory Group for Aerospace Research and Development - Standardized Tests for Research with Environmental Stressors (36)	1. Intended for drug testing 2. Complete battery 3. International standardization 4. Software available 5. Variable test duration	1. Single level of difficulty 2. Small selection of tests restricts possible future testing changes
WRPAB Walter Reed Performance Assessment Battery (48; 73)	1. Tests are short and may be administered repeatedly 2. Each subject is his own control 3. Excellent graphics and presentation	1. No dual-task capability 2. Single level of difficulty
UTC-PAB Unified Tri-Services Cognitive Performance Assessment Battery (56)	1. Will be DOD standard 2. Ease of user support 3. Is intended to measure drug effects 4. Is intended for military performance 5. Menu of tests to choose from for later changes to performance testing at AFIT 6. Is compilation of existing batteries 7. Dual-task, split attention capability	1. Unavailable in one package currently

Of those batteries, it is the Unified Tri-Services Cognitive Performance Assessment Battery (UTC-PAB) that meets the most of the requirements of AFIT research. The UTC-PAB is currently managed by the Office of Military Performance Assessment Technology (OMPAT) in Washington, at the Walter Reed Army Institute of Research. The battery is the result of a Tri-Service Joint Working Group on Drug Dependent Degradation of Military Performance in November 1984 (16:2; 56:7). The group was founded to standardize performance testing of chemical defense drugs. Accomplishing this would make multi-center, geographically diverse drug evaluations and data exchange possible (31).

The UTC-PAB is more appropriate for AFIT than the other batteries precisely because it is intended to be a tri-service standardization. It was created specifically to determine the effect of a drug on a military member's ability to perform their mission (16:2). It is not required that the various services use the UTC-PAB in all performance testing, but the incentive is the standardization with other researchers that it permits (31). By following the UTC-PAB procedure of testing, gaining military-wide acceptance of a drug will be less difficult. This was an important consideration in battery selection, since any motion sickness drug AFIT finds to be effective will be useful to all the services, not just the Air Force.

Another advantage of the UTC-PAB is that psychologists from the Workload and Ergonomics Branch of the Armstrong Aerospace Medical Research Laboratory (AAMRL) have been involved with the development of the UTC-PAB since its inception (61). Therefore, keeping up with software development, and obtaining support for AFIT use of the UTC-PAB is considerably easier with AAMRL support available locally.

A further benefit in using the UTC-PAB is its history as a military battery. It was designed to find the type of performance effects that are not acceptable in an operational environment, even though they may be acceptable in civilian use (31). The users of the battery also know the developers have extensively documented and researched each test's history, reliability, and uses (56). This keeps the users from having to start from scratch every time they seek a performance test. They do not need to regenerate all the data on which test is more often used, more reliable, or more valid than another. The UTC-PAB compilation has already done the initial work.

The twenty-five tests in the battery were selected from existing DOD performance batteries by the Working Group. The UTC-PAB's genesis as a performance battery for drug effects is right in line with the drug testing AFIT is doing. In addition, since the tests are included in menu form, the test selection can be changed to meet future AFIT testing needs.

Of the many batteries examined, the UTC-PAB was one of the few with dual-task capability. This characteristic will be explained in further detail in Chapter 5. The dual-task option greatly increases test sensitivity (18:259). As mentioned earlier, heightened sensitivity is an important factor in being able to pick up performance effects previously refuted in AFIT research.

Unlike some of the other batteries, the UTC-PAB is still growing, so there is no single software package yet that encompasses all twenty-five tests. That software is in the making. Consequently, implementation is more complicated than that of an off-the-shelf finished battery. The UTC-PAB is a standardized, flexible performance battery oriented toward military drug testing. Thus, the overall advantages of a tri-service battery outweigh the implementation complications.

Possible Test Choices Within UTC-PAB

The UTC-PAB is a menu of possible tests. Once the decision is made to use this battery, a subset of the tests are chosen that are suitable to the particular experiment. Though this does not provide the comprehensive coverage of running every test in the battery, that is rarely a practical option.

Table 8: UTC-PAB Organization Scheme (56:11)

Category	Tests Within Category
Perceptual Input, Detection, and Identification	Visual Scanning Task Visual Probability Monitoring Task Pattern Comparison (Simultaneous) 4-Choice Serial Reaction Time
Central Processing	Auditory Memory Search Continuous Recognition Task Code Substitution Task (also known as Digit Symbol) Visual Memory Search Item Order Test
Information Integration/Manipulation -- Linguistic/Symbolic	Linguistic Processing Task Two-Column Addition Grammatical Reasoning (symbolic) Mathematical Processing Grammatical Reasoning (traditional)
Information Integration/Manipulation-- Spatial /Mode	Spatial Processing Task Matching to Sample Time Wall Matrix Rotation Task (Spatial Processing Task) Manikin Test Pattern Comparison (Successive)
Output Response Execution	Interval Production Task Unstable Tracking Task
Selective/Divided Attention	Dichotic Listening Task Memory Search/Unstable Tracking Combination (Sternberg Tracking Combination) Stroop Test

The UTC-PAB documentation recommends an initial subset of one or two tests from each category (56:10). Then, if those tests do uncover a performance decrement in a number of subjects, a future battery can involve more tests from the category where the deficit was found. Currently, OMPAT is still working to compile a standard subset of tests to recommend for initial drug effects screening. Since no such recommendation is currently available, the decision on which tests to use in AFIT testing was based on other criteria (which are discussed in the next section).

UTC-PAB Tests Chosen for Use in AFIT Research

The first performance tests chosen from the six UTC-PAB categories were 4-Choice Serial Reaction Time, Code Substitution, Mathematical Processing, Time Wall, Manikin Test, Memory Search/Unstable Tracking, and the Stroop Test. However, when implementation of the initial selection of tests were tried, certain problems came up. This section describes how and why the initial test selection had to be changed. The following two sections give a detailed description of the final tests and the reason behind their selections .

First of all, there simply is not enough time to run each subject through seven tests. Realistically, the performance testing portion of the experiment should take each subject less than 30 minutes. This cannot be done when the subject is asked to fill out symptom questionnaires, read instructions, and then take five computerized tests. The time required is more on the order of 45 minutes. Therefore, in the interest of having a reasonable length battery, the Stroop Test and Time Wall were dropped. Eliminating the Stroop Test still left the Memory Search/Unstable Tracking task in the Selective/Divided Attention category. Similarly, eliminating Time Wall from the Information (Spatial/ Mode)

category still left the Manikin Test as part of the battery. The tests that were dropped were less widely used than the remaining tests.

Secondly, Code Substitution had to be dropped as a selected test because it was too difficult. Code Substitution (also called Digit Symbol) is both a mental and motor task (38:618) that is used extensively in motion sickness drug testing, as shown by Table 1. Further, the test is a "mixed associative memory and perceptual speed test which provides for a traditional assessment of components not otherwise covered by other measures ... and has considerable face validity for military tasks" (38:618). The literature review showed use of Code Substitution as a performance test to be so common, that its selection for AFIT use was obvious. However, the software form of the test available to AFIT (the AGARD-STRES) differed from the UTC-PAB specifications in one important way. The following is a description of the test as given in the UTC-PAB specifications.

> A string of nine letters and a string of nine digits are arranged on a CRT display so that the digit string is immediately below the letter string. Each digit corresponds to a given letter. A test letter is then presented at the bottom of the screen, **below the two coding strings**. The subject is to indicate which digit corresponds to that test letter in the coding strings by pressing a designated key on a numbered keypad (56: 198).

The main difference is the visibility of the coding strings. In the UTC-PAB version, the strings remain visible while the subject takes the test. However, in the version of Code Substitution available in the software, the strings disappear. This makes the test unreasonably hard. A number of test subjects tried the version of the test where the strings disappear and found it to be very difficult and

quite frustrating. Thus, Code Substitution was eliminated from the battery and replaced with Visual Memory Search.

So, the final test selection (one from each category) for the AFIT performance testing battery included 4-Choice Serial Reaction Time, Visual Memory Search, Mathematical Processing, Manikin Test, and the Memory Search/Unstable Tracking.

Test Descriptions

Before it is possible to discuss the reasons behind the various tests selections, it is important to understand what the tests are. The following descriptions of the final test selections are taken directly from the Unified Tri-Services Cognitive Performance Assessment Battery: Review and Methodology (56). For more detailed descriptions see the referenced manual.

Four-Choice Serial Reaction Time (UTC-PAB Test #7)

> [Tests encoding, categorization, response selection]...A blinking "+" sign imposed on the cursor in one of four quadrants of a CRT is presented to the subject. The subject is instructed to press the key (one of four) on the keyboard that corresponds to the quadrant with the blinking "+". The blinking "+" remains in the quadrant until one of the four keys is pressed and then randomly reappears in any one of the quadrants (56:87).

Visual Memory Search (UTC-PAB Test #9)

> [Tests short-term working memory] Either one, two, four, or six alphabetic characters make up the "positive set" which is presented to the subject to maintain in memory. The remaining alphabetic characters make up the "negative set". Subsequent to the presentation of the "positive set", individual probe letters are presented to the subject for comparison and classification as being members of the positive set or the negative set. Subjects respond by pressing the appropriate key...
>
> There are three different procedures used in this task...In the varied set procedure (VS) a different positive set is generated on every trial followed by a single probe item. The fixed set procedure (FS) involves the presentation of the positive set followed by 100 probes to constitute a trial.

A trial in the mixed set procedure (MS) consists of the presentation of 10 separate positive sets of equivalent size, each of which is followed by 10 probes for classification with respect to the set (56:110).

Mathematical Processing Task (UTC-PAB #5)

[Tests number facility and general reasoning] This test requires subjects to perform one or more addition and/or subtraction operations on single digit numbers and determine whether the answer is greater or less than five. The three version of this test are as follows: (a) low demand version -- problems containing one mathematical operation (b) moderate demand version -- problems containing two mathematical operations, and (c) high demand version -- problems containing three mathematical operations (56:61).

Manikin Test (UTC-PAB Test #13)

[Spatial orientation rotation ability] The test will consist of a series of 64 trials presented to the subject. On each trial, the subject will see a human figure (the manikin) displayed on the CRT. The figure will be in one of four orientations: (a) facing toward the subject; (b) facing away from the subject; (c) right side up: or (d) upside down. In each hand, the manikin holds a box of different color (either red or blue). The manikin stands on a platform that matches the color of a box in his hand. The subject's task is to indicate the hand (right or left) which is holding the box that matches the platform color (56:155).

Memory Search - Tracking Combination (UTC-PAB Test #23)

[Tests time sharing ability] This is a dual task paradigm involving Unstable Tracking and the Sternberg Memory Search. Subjects are required to track with their left hand and respond to the memory search stimuli with their right hand (56:278).

Unstable Tracking tests information processing resources dedicated to the execution of rapid and accurate manual responses. Subjects view a video screen which displays a fixed target area at the center. A cursor moves vertically from this target while the operator attempts to keep the cursor centered over the target via rotary movement of a control knob. The system is inherently unstable; operator input introduces error which the system magnifies so that it is increasingly necessary to respond to the velocity of the cursor movement as well as cursor position (56:263).

This memory search task tests a subject's ability to make comparisons of letters maintained in memory... Either one, two, four, or six alphabetic characters make up the 'positive set' which is presented to the subject to maintain in memory. The remaining alphabetic characters make up the 'negative set.' After presentation of the 'positive set,' individual probe

letters are presented to the subject for comparison and classification as being members of the positive set or the negative set (56:110).

Reasons for Test Selection

The UTC-PAB designers used a number of criteria to select the tests in the battery. The tests had to form a part of a comprehensive menu; a menu that would give researchers a sufficiently wide selection (59:3). To avoid excessive theoretical disputes, multiple versions of the same test were included, leaving the choice to the individual researchers using the battery (59:3). Finally, the UTC-PAB tests were all included in the battery for their reliability, validity, and sensitivity (59:3). This made all twenty-five of them valid possibilities for AFIT use.

As mentioned earlier, relevance to operation skills, history of use in antimotion sickness drug research, and sensitivity to small changes in performance were all considered in AFIT test selection. The six categories shown in Table 8 are reiterated below with reasons for the test selection from that category

Perceptual Input, Detection, and Identification Category. 4-Choice Serial Reaction Time was the most appropriate test from this category for AFIT purposes. Reaction time tests are one of the most basic and frequent tests used in motion sickness performance assessment and in phenytoin performance assessment (see Tables 1 and 2). Further, this particular test is a choice reaction time, the subject must not simply respond to seeing a "+", but must also identify its location (30:125). This tests a higher level of processing than a simple reaction time test.

Central Processing Category. In this category, the choice was originally Code Substitution. After its elimination, the next best alternative was a Memory Search task. Short-term memory testing tasks are used reasonably frequently in

performance testing (see Tables 1 and 2), but with nowhere near the frequency of Code Substitution. However, the task does have a history of being used specifically in drug research (36:27; 56:127). Another benefit of using this task is it allows subjects to practice Memory Search before they have to do it as part of the Memory Search / Unstable Tracking Dual Task.

The other options in this category, Continuous Recognition Task and Item Order Test have not been used extensively in drug testing, so far (56:81,301). It is hoped that a version of Code Substitution that meets the UTC-PAB test description will be available in the future. At that time, including that test in the AFIT battery again is a definite consideration.

Information Integration/Manipulation --Linguistic/Symbolic Category. The test chosen from this category was Mathematical Processing. The current AFIT testing battery includes another choice from this category, Grammatical Reasoning. However, all data using this test showed no significant differences (see Table 5). Granted, this could be because there is no difference to find, but it could also be because Grammatical Reasoning is not a sensitive enough test. Since Mathematical Processing has often "been identified as a factor in factor-analytic studies of skilled performance" (36:7), it was picked as the choice in this area. Mathematical tests are also frequently used in phenytoin side effects testing (see Table 2), as well as performance tests used to measure the effects of motion sickness (12:417-421).

Information Integration/Manipulation--Spatial Mode. The Manikin test was chosen from this category. It is a spatial orientation task similar to that required by many military and space activities (56:156). As pointed out by the UTC-PAB: Review and Methodology, the human figure used in Manikin makes it an easier

performance test to understand than some more abstract spatial orientation tests (56:158).

Output/Response Execution. Unstable tracking is used in the current CTS battery and no subject had significant performance differences. Therefore, no individual test was chosen from this category. Instead, the combination version of Unstable Tracking from the next category was selected to try to achieve greater sensitivity and satisfy the requirements of this category at the same time.

Selective/Divided Attention. One way to achieve greater sensitivity in performance testing is to load the subject by giving him more than one task at a time (16:7; 28:372). In studies done on the performance effects of blood alcohol level, certain performance tests by themselves were less sensitive to changes than when they were combined into a dual-task, which stress the operator's abilities further (18:259). The CTS battery, currently in use at AFIT, has no multiple task capability.

Dual-task division of attention is a factor in many operational environments. The AGARD-STRES (Advisory Group for Aerospace Research and Development -Standardized Tests for Research with Environmental Stressors) chose the Memory Search/Unstable Tracking dual task combination because of their "relevance to continuous control tasks, such as flying, in which there are periodic demands upon working memory" (36:8). The task is included in the proposed subset of UTC-PAB tests for similar reasons. The ability to follow or "track" is a major component of many military skills (55:654).

V. Implementation

This section describes the recommended changes in procedure for performance testing of antimotion sickness drugs at AFIT and procedures for implementing the changes.

Procedural Changes

Equipment Location. The performance testing battery equipment should be located in a quiet room or area. The subject needs to take the performance testing battery in a place where he can be as free from distractions as possible.

Subjective Reporting of Side Effects. Concerning the use of questionnaires to report subjective side effects of drugs, it is important to note that "if any sample of the healthy population is given a printed form containing simple questions about symptoms of ill health, 63% to 94% of the subjects will record at least one symptom, such as headache, drowsiness, giddiness, or dryness of the mouth" (21:25). As Glaser reports, this surprising finding has been duplicated many times with a wide variety of subject populations (21:26). The reasons for this high incidence of symptom reporting could be explained by a tendency to answer yes to questions, or by a tendency to become more aware of a symptom once attention has been drawn to it, or by a tendency toward hypochondria (21:26). Regardless of the reasons for such a high baseline reporting of symptoms, this factor must be considered when using questionnaires. The questionnaire is further subject to "deliberate false answers, topicality of questions, and increasing test sophistication in the general population" (49:87). On the other hand, performance tests can be insensitive to some effects truly felt by the subject (37:410). Nevertheless, it is important to

have both questionnaires and performance tests to obtain a complete picture of how the subject is responding to the drug in question. Currently, the subjects report their feelings of side effects to the researcher but do not write them down.

One of the methods used frequently to report subjective side effects in a written form is the Cornell Medical Index (CMI) (79:158; 80:114; 81:311). However, upon examination of the CMI's use in the various experiments referenced, it was clear that it had been heavily altered for those particular experiments (10). The actual CMI is a questionnaire about the subjects' medical history, rather than an assessment of their current symptoms.

The results of the literature review in this area showed two things. There is some standardization in the area of determining how subjects feel psychologically, with a number of researchers using either the Profile of Moods States or Moodscale II (44:392; 71; 74). The Profile of Moods States is a copyrighted document that is often somewhat expensive to use. The questionnaires cost money to obtain and to score. Moodscale II, on the other hand, is a computerized questionnaire already built into the Walter Reed Performance Assessment Battery (WRPAB). It asks subjects to rate how they feel (irritated, angry, drowsy, etc.) on 65 adjectives on a scale of 1 to 3 (73: 416). Since some of the tests selected for AFIT performance testing are in the WRPAB, it is a simple matter logistically to include Moodscale II in the battery. The test is scored automatically and without cost, a considerable advantage over the Profile of Mood States.

The second finding of the literature review was there may be some standardization in determining how a subject feels emotionally, but there is very little standardization in determining how they feel symptomatically (71;74; Tables 1 and 2). The Profile of Mood States or Moodscale II will ask if a subject feels

angry or sad, but not if they have dry mouth, blurred vision, or other physiological symptoms associated with antimotion sickness drug treatments.

The Office of Military Performance Assessment Technology (OMPAT) suggested the Environmental Symptoms Questionnaire (ESQ) as a starting place (31). The ESQ is used by the US Army Institute of Environmental Medicine, but it is by no means a standard tool in performance testing. Upon examination of the ESQ documentation, it was apparent the items on the questionnaire were inappropriate for AFIT testing (17). The ESQ is intended to capture symptoms relating to altitude sickness (39: 925; 62: 872). For example, the ESQ checks if the subjects had a nose bleed. Thus, the ESQ has a number of items that are very applicable to altitude sickness, but less so to motion sickness research.

Other researchers have designed their own questionnaires for assessing subjective reports of side effects (see Table 1). The School of Aerospace Medicine developed a Symptoms Checklist that has been in Air Force use since the mid-1970s, and it has a large normative database to support it (63). The Symptoms Checklist is simple and to the point. Given its obvious development for drug effects testing, it would be quite useful for AFIT purposes. The checklist is reprinted, with permission, in Appendix C.

Moodscale II will ask a subject how he feels emotionally. Then, the Symptoms Checklist will give him a chance to document how he feels physiologically. Putting both together lets the researchers construct a comprehensive picture of the volunteers' own assessment of the drug side effects. This provides a standardized and written record for comparison with performance battery results.

UTC-PAB Complications

When finalized, the UTC-PAB will be a computerized test system complete with supporting documentation (16: 1). It is written in the common software language of C and runs on IBM PCs and compatibles (16:2). As mentioned earlier, the UTC-PAB is still incomplete from a hardware/software point of view. Therefore, the decision to use the UTC-PAB anyway requires piecing together the chosen tests from other software sources.

The UTC-PAB is a selected subset of tests from other DOD batteries; many of which are still in use (31). Therefore, given the incomplete UTC-PAB software, the tests can be obtained from their original sources. However, reaching into other batteries to find the UTC-PAB tests does create some difficulties. The names of the tests may be different. Also, the versions of the tests may differ drastically -- as with Code Substitution.

Chapter IV described five UTC-PAB tests proposed for use in future AFIT motion sickness drug performance testing. Of the five chosen, two are available on the Walter Reed Performance Assessment Battery (WRPAB). The two tests taken from the WRPAB are 4-Choice Serial Reaction Time (known as Wilkinson Serial Reaction Time in the WRPAB) and Manikin. Moodscale II, the subjective emotional states assessment mentioned earlier, is also included in computerized form on this battery. The Naval Aerospace Medical Laboratory developed a version of the AGARD-STRES that will be compatible with the UTC-PAB battery and system (60:1). The other three tests selected (Mathematical Processing, Memory Search Task --Fixed Set Version, Memory Search/Unstable Tracking) are available on the this version of the AGARD-STRES Battery.

Since all five tests are important to having a complete test sample, especially the dual-task capability available only on AGARD-STRES, the AFIT

battery will have to consist of the relevant pieces of both of these batteries. Neither the WRPAB alone or the AGARD-STRES alone can meet the needs of AFIT research (see Table 7). However, when put together, they contain the five tests selected for AFIT use.

Fortunately, these two batteries were easy to obtain and uncomplicated to implement. Both batteries were available free of charge under two conditions. The first condition is that users credit the origins of the batteries. Secondly, users are asked to submit any data generated with the batteries for inclusion in a general archive.

Should future performance testing changes require UTC-PAB tests that are not part of the AGARD-STRES or WRPAB menus, those tests will have to be pieced in from other sources. This is a real disadvantage to the UTC-PAB. However, as the UTC-PAB software becomes more complete, more tests should be available as part of the direct package. Another possibility is the WRPAB will have added the needed tests to its growing menu.

Implementation of the AFIT Performance Battery

Both the WRPAB and AGARD-STRES have specific hardware requirements. The current performance testing setup at AFIT encompasses most of the hardware required for running these two batteries with two exceptions. A joystick (for AGARD-STRES dual task) and a multiple plug-in timer card are necessary (36; 48; 60:7-9). Specifications for both are in Appendix B.

The appropriate hardware is being procured. In the interim, the AFIT system is running on Armstrong Aerospace Medical Research Laboratory (AAMRL) duplicate hardware. The WRPAB battery and the AGARD-STRES are

installed on the laboratory computer and AFIT-specific batteries have been created from the menu of each package.

Both the WRPAB and the AGARD-STRES have nicely detailed and extensive documentation on how to use each battery, how to configure it, how to tailor specific batteries, how to obtain printouts, etc. These manuals and backup copies of all the software are housed in the Motion Sickness Laboratory. An index of the major software documentation is included in Appendix F.

Complete Performance Testing Session

The administration of the complete performance testing session is similar to the process already in place, but the session now uses different tools. The subject has a baseline testing session and sessions before each chair ride, just as before.

The subjective side effects questionnaire (Symptoms Checklist) should be administered before the performance batteries. Since the Moodscale II feelings assessment should be given right after the Symptoms checklist, the WRPAB needs to be the first battery run (since it contains Moodscale II). The order of administration of tests within either the WRPAB or the AGARD-STRES is flexible and open to further experimentation. Instructions for creating future batteries and preparing for a performance testing session are in Appendices D and E. Appendix G has instructions for a subject's practice testing session. Appendix H contains the specific instructions that allow a subject to take his performance tests.

Support

There is an electronic bulletin board run through the Office of Military Performance Assessment Technology that is an excellent source of information, the latest software, and support on the UTC-PAB and other performance assessment methods. A large number of UTC-PAB users and experts can be reached through this medium.

In addition, since there are so many changes and developments in the arena of military performance assessment, future AFIT researchers need to avail themselves of the local AAMRL resources. Mr. Gary Reid and Mr. Mark Crabtree of the Workload and Ergonomics Branch at AAMRL are in the business of keeping up with changes in performance assessment and software updates. They are in regular contact with the Office of Military Performance Assessment Technology, the organization that manages and distributes the UTC-PAB. If future research students make themselves known to Mr. Reid and his group, they will benefit immensely from their assistance in matters of software glitches or future battery upgrades.

VI. Recommendations and Conclusions

This research was devoted entirely to tearing down and rebuilding the Air Force Institute of Technology's drug performance assessment process, starting at ground zero. That is only a small piece of the overall motion sickness research at AFIT. No future AFIT motion sickness researchers should have to again devote all of their efforts to the performance assessment aspect. With the new batteries in place, performance testing should be like any other portion of the AFIT research, building on the previous year's work. The next team of researchers will be able to continue with the actual drug testing and devote only a portion of their energy to implementing and improving the performance testing procedure.

It is also very important that AFIT and AAMRL maintain the ties developed during this research. The proximity of AFIT to Mr. Reid's group at AAMRL ensures a support network that allows AFIT to stay abreast of UTC-PAB changes and obtain performance testing assistance when necessary.

Work is already in progress on validating the assessment procedure. After a baseline of subjects is run, it will be possible to make judgements on the practical use of the AFIT batteries. The actual implementation of a new testing battery will raise questions about appropriately tailored statistics, difficulty levels, new/alternate test selections, software simplifications, etc. All manner of issues will come up when the batteries are actually being used on a day-to-day basis.

The subset of five tests chosen from the UTC-PAB is a strong starting place for isolating drug performance effects. The tests were basically selected to be relevant to operational skills and difficult enough to force out performance changes. Naturally, there is no guarantee that the chosen tests are sensitive

enough to pick up all performance decrements. However, since the AFIT batteries are a subset from a larger menu, choosing other tests or zeroing in on one area of performance change (to see if they provide alternate results) will be relatively simple. The menu driven-nature of the WRPAB and AGARD-STRES will make makes these future test changes uncomplicated to implement (as long as the tests are available in these batteries).

When the complete version of the UTC-PAB battery is available, certain upgrades will be needed. First of all, the WRPAB and AGARD-STRES will no longer be necessary. The entire AFIT battery will be a subset of only the UTC-PAB software. For the time being, the subjects will have to be taken through the two AFIT batteries as separate entities. When the UTC-PAB package is ready, the Code Substitution test should be put back into the AFIT battery. In addition, as soon as it is possible from a software perspective, all the tests should be administered under varying levels of difficulty. The researchers will have to experiment with what level of difficulty is necessary to draw out any existing performance changes. Increasing difficulty levels can be as effective as dual-tasking for detecting slight performance changes (59:7). Further, when more dual-task testing capabilities are incorporated into the UTC-PAB, they should also be added to the AFIT testing. As future teams of researchers implement these changes and see the need for others, they should be able to make the necessary modifications with AAMRL's help.

The improved performance testing method and the future avenues of improvement recommended here will help the AFIT motion sickness research effort press forward in its attempt to prove/disprove the usefulness of anticonvulsant drugs in stemming motion sickness. The UTC-PAB is an important effort to eliminate the non-productive lack of standardization within the

military performance testing establishment. Use of the UTC-PAB ensures the drug testing being done at AFIT is grounded in a widely accepted, mainstream military procedure.

Motion sickness is a common and costly ailment that hampers military operations constantly. AFIT's attempt to find a drug capable of decreasing the losses in time and dollars due to motion sickness will only be complete when the performance effects of phenytoin and other proposed antimotion sickness drugs have been fully explored and quantified.

Appendix A: Known Side Effects of Some Antimotion Sickness Drugs and Phenytoin

Drug and References	Dosage	Side Effects
Cyclizine (Marezine) (12:347; 15: 261; 45:105)	less than 200 mg per day	dizziness drowsiness lessened alertness dryness of mouth
Dextro-amphetamine (45:164)	varies [typically 5-10 mg]	insomnia dizziness a "high" feeling impaired judgement headache diarrhea flight of ideas agitation paranoid thoughts
Dimenhydrinate (12:345; 15:262; 45:107)	50 mg dose	drowsiness dizziness
Diphenhydramine (Benadryl) (45:55)	150-200 mg/day	drowsiness dizziness dry mouth headaches nausea muscle twitching reduced mental alertness
Meclizine (Bonine, Antivert) (12:348; 15:263; 45:110)	25 mg dose	drowsiness dry mouth blurred vision dizziness fatigue
Phenytoin (Dilantin) (45:148; 57:1539)	100 mg dose three times daily (sic)	dizziness slurred speech mental confusion transient nervousness motor twitchings headaches nystagmus ataxia insomnia

Appendix A (Cont)

Drug and References	Dosage	Side Effects
Promethazine (Phenergan) (12:345; 15:263; 45:114; 57: 2238)	25 mg oral dose	drowsiness sedation dizziness dry mouth vomiting nausea blurred vision change in blood pressure diminished mental alertness
Transdermal Scopolamine (12:345; 15:261; 45:183; 57:866)	one disc giving .5 mg over 3 days	dryness of the mouth drowsiness transient eye accommodation impairment blurred vision pupil dilation memory loss mental confusion decreased mental alertness pulse rate changes mydriasis amnesia fatigue

Appendix B: Joystick and Plug-in Timer Card Specifications

Multiple-Timer Plug-in Card

The following specifications are taken directly from the Walter Reed Performance Assessment Battery Documentation. Hardware/Software Requirements (48).

A multiple-timer plug-in card. The PAB program uses a multifunction card for timing stimulus durations, interstimulus intervals, feedback intervals, reaction times and task durations. (The time-of-day clock is not accurate enough for most of these uses). Compatible timer boards are available from several different manufacturers at widely different prices. The more expensive of these provide 24 digital I/O lines, and several channels of 8 or 12 bit A-to-D and D-to-A converters, in addition to the 5 timers. These functions may be used in future batteries for custom "button boxes", tracking devices and audio tome generation but are not used in the standard PAB.

The least expensive board is the CTM-05 timer from Metrabyte Corp., 440 Myles Standish Blvd., Taunton, MA,02780. Phone (508) 880-0179 (approx $300). The same card is available from Perx, 1730 South Amphlett Blvd., San Mateo, CA, 94402 (800) 722-7379 (usually with a slight markup).

Other alternatives are the Labtended card (8-bit)(approx $600) and the Labmaster card (12-bit) approx $1100). Both are available through Hallmark Electronics (a national chain) and from the manufacturer Scientific Solutions, Inc., Cleveland, OH (216) 349-0600.

Another alternative is the SRL PC-Labpac (12 bit, plus two speech synthesizer channels) (Approx $1400) from Systems Research Laboratory, 2800 Indian Ripple Rd., Dayton, OH, 45440, (513) 426-6000. Different options and prices are available.

Joystick

The range of movement of the lever should be 30 degrees left and right from the vertical position. The friction of the moving parts should not exceed 50 g, and should be constant over the range of travel. The relationship between angular rotation of the joystick and lateral movement

of the cursor should be linear for the entire range of travel. Analogue-to-digital conversion of joystick potentiometer values should be conducted to at least 8-bit resolution. In other words, rotation of the joystick should produce at least 256 discrete values (36:9).

The stick currently in use at AAMRL is model MS4M 6676 from OEM Controls, 10 Controls Dr., Shelton, CT 06484, (203) 929-8431.

Appendix C: USAFSAM Symptoms Checklist :(75)

Date:_____
Time:_____

ID #_____

SYMPTOM CHECKLIST

Please circle below if any symptoms apply to you right now. If you answer YES, circle the number which best describes the degree of the symptom.

			SLIGHT		MODERATE				SEVERE
1.	Headache	NO YES	1	2	3	4	5	6	7
2.	Drowsiness	NO YES	1	2	3	4	5	6	7
3.	Irritability	NO YES	1	2	3	4	5	6	7
4.	Depression	NO YES	1	2	3	4	5	6	7
5.	Dizziness (eyes open)	NO YES	1	2	3	4	5	6	7
6.	Dizziness (eyes closed)	NO YES	1	2	3	4	5	6	7
7.	Vertigo	NO YES	1	2	3	4	5	6	7
8.	Confusion	NO YES	1	2	3	4	5	6	7
9.	Giddiness/Euphoria	NO YES	1	2	3	4	5	6	7
10.	Faintness	NO YES	1	2	3	4	5	6	7
11.	Fatigue	NO YES	1	2	3	4	5	6	7
12.	Boredom	NO YES	1	2	3	4	5	6	7
13.	Inability to think	NO YES	1	2	3	4	5	6	7

14.	Numbness	NO YES	1	2	3	4	5	6	7
15.	Tingling	NO YES	1	2	3	4	5	6	7
16.	Hot/cold flashes	NO YES	1	2	3	4	5	6	7
17.	Awareness of Breathing	NO YES	1	2	3	4	5	6	7
18.	Rapid Breathing	NO YES	1	2	3	4	5	6	7
19.	Irregular Breathing	NO YES	1	2	3	4	5	6	7
20.	Chest pain	NO YES	1	2	3	4	5	6	7
21.	Difficulty Breathing	NO YES	1	2	3	4	5	6	7
22.	Rapid heart beat	NO YES	1	2	3	4	5	6	7
23.	Pounding heart beat	NO YES	1	2	3	4	5	6	7
24.	Irregular heart beat	NO YES	1	2	3	4	5	6	7
25.	Eye strain	NO YES	1	2	3	4	5	6	7
26.	Difficulty focusing	NO YES	1	2	3	4	5	6	7
27.	Blurred vision	NO YES	1	2	3	4	5	6	7
28.	Visual illusions	NO YES	1	2	3	4	5	6	7
29.	Tearing	NO YES	1	2	3	4	5	6	7
30.	Nausea	NO YES	1	2	3	4	5	6	7
31.	Belly ache	NO YES	1	2	3	4	5	6	7
32.	Stomach discomfort (awareness)	NO YES	1	2	3	4	5	6	7
33.	Loss of appetite	NO YES	1	2	3	4	5	6	7
34.	Increased appetite	NO YES	1	2	3	4	5	6	7
35.	Sweating	NO YES	1	2	3	4	5	6	7
36.	Burping	NO YES	1	2	3	4	5	6	7
37.	Vomiting	NO YES	1	2	3	4	5	6	7
38.	Increased Gas	NO YES	1	2	3	4	5	6	7

39.	Want to move bowels	NO YES	1	2	3	4	5	6	7
40.	Diarrhea	NO YES	1	2	3	4	5	6	7
41.	Salivation increased	NO YES	1	2	3	4	5	6	7
42.	Salivation decreased	NO YES	1	2	3	4	5	6	7
43.	Dry mouth	NO YES	1	2	3	4	5	6	7
44.	Thirsty	NO YES	1	2	3	4	5	6	7
45.	Muscle cramping	NO YES	1	2	3	4	5	6	7
46.	Muscle twitching	NO YES	1	2	3	4	5	6	7
47.	Muscle weakness	NO YES	1	2	3	4	5	6	7
48.	Muscle incoordination	NO YES	1	2	3	4	5	6	7
49.	Muscle fatigue	NO YES	1	2	3	4	5	6	7
50.	Nose bleed	NO YES	1	2	3	4	5	6	7
51.	Shortness of breath	NO YES	1	2	3	4	5	6	7
52.	Ringing in ears	NO YES	1	2	3	4	5	6	7
53.	Itching	NO YES	1	2	3	4	5	6	7
54.	Chills/Shaking	NO YES	1	2	3	4	5	6	7
55.	Other symptoms?	NO YES	1	2	3	4	5	6	7
	List 55.	NO YES	1	2	3	4	5	6	7
	56.	NO YES	1	2	3	4	5	6	7
	57.	NO YES	1	2	3	4	5	6	7
	58.	NO YES	1	2	3	4	5	6	7
	59.	NO YES	1	2	3	4	5	6	7

Tester's use: Number of Symptoms: Symptom Score:

Appendix D: Creating a Battery

There are instructions for both the WRPAB and the AGARD-STRES on how to create or modify a battery (Appendix F has a list of such manuals). The information below is specifically relevant to creating a battery to be executed on the AFIT Motion Sickness Lab Zenith Z-248.

Notes on AGARD-STRES Battery Creation

The software will ask for certain information about the equipment being used. The information below is needed to answer those questions.

1. The interrupt setting (in the setup file under Miscellaneous) must be set to 2 for the Dual-Task to operate correctly.
2. The monitor type is EGA (8).
3. *Control* - C exits the system.

Note that the response keys that are used can be changed, if so desired. See the UTCPAB-AGARD STRES manual under Setup (page 15). In addition, the new battery can consist of any subset of tests desired. Even though the AGARD-STRES is often run as a complete battery, specific tests can be run by themselves.

Notes on WRPAB Battery Creation

The software will ask for certain information about the equipment being used. The information below is needed to answer those questions and proceed through the introduction.

1. The multiple plug-in timer card in use is the SRL Labpac.
2. The computer has EGA graphics.
3. The version of Basic that the WRPAB is written in is the same as that on the computer (8).
4. The system must have loaded BASICA before it can begin doing anything.
5. Before the tests have started, type **CTRL-C** or **CTRL-BREAK** to exit. To exit while the tests are executing, hold down the **ALT** key and type the letters **B R E A K**. To resume the program type **RUN** or press **F2**. Typing **GOTO 54321** will abort the session permanently. Type **SYSTEM** to exit BASICA (48).

Note that in any future battery constructed, Moodscale II should still be the first thing the subject takes. Since the subject fills out the Symptom Checklist as soon as he arrives, the Moodscale II assessment needs to be done as close to that as possible (they both ask how the subject is feeling at that precise time).

Appendix E: Instructions for a Performance Testing Session

1. When the subject comes in for his chair ride, give him his medical exam. During this time, make sure there is a data disk for the subject's performance battery results, and that it is appropriately labeled (48). Check to make sure the printer is enabled and has paper.

2. Give the subject a copy of the Symptoms Checklist.

3. While the subject is filling out the questionnaire, prepare the performance batteries. Remember: Before the tests have started, type **CTRL-C** or **CTRL-BREAK** to exit. To exit while the tests are executing, hold down the **ALT** key and type the letters **B R E A K** . To resume the program type **RUN** or press **F2** . Typing **GOTO 54321** will abort the session permanently. Type **SYSTEM** to exit BASICA (48).

   a. Turn on the system.

   b. At the C : \ > prompt, type **cd wrpab**.

   c. At the C : \ WRPAB > prompt, type **basica**.

   d. At the OK prompt , press **F3**.

   e. At the LOAD" prompt , type **AFITPAB1"**.

   f. Press **Return**.

   g. At the OK prompt, press **F2**.

   h. Insert the data disk and press **Return**.

   i. Subject number:

      Type in the subject's assigned number.

      Session number:

      If this is the subject's first session, type in **01** when asked for session number and see Appendix G for practice

instructions to give to the subject, in addition to the ones below. If it is not the subject's first session, enter the appropriate session number.

Auto or Resume:

Type in **0** for auto. If the battery has been interrupted for some reason and the session needs to be restarted, type in **1** for resume.

j. Follow the instructions on the screen.

k. The introductory screen for the Walter Reed Performance Assessment Battery should be on the screen.

4. Instructions to the subject:

a. "This is not an IQ test, but a number of short performance tasks to measure things like short-term memory, reaction times, and your own assessments of how you feel at the moment. Please, remember to keep your fingers in contact with the keys throughout each task. Between each task you may remove your hand from the keyboard and flex it, etc. Please do not talk, eat, or drink during the tests themselves. Try to be as accurate and fast as possible. Both are being measured" (48).

b. Point out that the first task the Moodscale II, is an assessment of how he feels, not a test.

5. Have the subject begin the battery.

6. The WRPAB will automatically print out summary statistics for the session.

7. To exit the WRPAB and proceed into the AGARD-STRES, type **SYSTEM**.

8. Next, the subject needs to take the tests in the AGARD-STRES. The menu containing the AFIT chosen tests of Mathematical Processing, Memory Search,

and Memory Search/Unstable Tracking has already been created. To prepare it for the subject's use, follow the instructions below. (CTRL-C allows exit if needed).

a. At the C : \ WRPAB > prompt, type **CD\AGARD**.

b. At the C : \ AGARD > prompt, type **setup**.

c. At the setup screen, press **Return**.

d. At the Main Menu, type **1**. Check to make sure all parameters are correct.

   1. The setup path should be **C:\AGARD**.
   2. The random selection type should be **Session**.
   3. The I/O board type should be **Labpak**.
   4. The interrupt setting should be **2**.
   5. The I/O board starting port address should be **0280**.
   6. The monitor type is **EGA**.
   7. Partial data should be **Saved**.
   8. Type **Y** to leave the screen when the values are correct.

e. At the C : \ AGARD > prompt, type **menu**.

f. The initial battery screen will show up, press **Return**.

g. At the General Information Screen, press **Return**.

h. At the Main Menu screen, type **1**.

i. At screen 2, Input all the appropriate data.

   1. Check Subject ID.
   2. If this is the subject's first session, type **P** for Practice. This option means instructions and feedback will appear for each task. Otherwise, type **T** for Test.
   3. Check the Run Number.

4. Enter whether the subject is right-handed or left-handed.
5. Select Paused or Continuous. Type **C** for Continuous. Selecting the Paused option means the subject will have to press Return to move to the next task. Continuous makes the tasks execute in order without subject input.
6. For type of run, type **E** for Entire. Selecting the Single option means the battery will only execute the tasks that are selected for that run. Selecting Restart allows the battery to be completed automatically from the place where it was halted. Entire runs the whole battery automatically.
7. Answer the correct, incorrect prompts at the bottom of the screen.

j. At the next screen, make sure the tasks to be run are Mathematical Processing, Memory Search (2-Character), and Dual-Task (2-Item). If they are correct, type **EX** to exit.

9. Give the subject a copy of the Test Instructions for the Practice Session (Appendix G) and have him take the battery.
10. Battery returns to the Main Menu. Typing **EX** brings the C:> prompt back.
11. Have the subject prepare to ride the motion sickness chair.

Appendix F: Documentation Index

The following are the major supporting documents for the AFIT performance testing batteries. They are located in the Motion Sickness Research Laboratory.

1. The Unified Tri-Service Cognitive Performance Assessment Battery (UTC-PAB) I: Design and Specification of the Battery, 1987.

2. The Unified Tri-Service Cognitive Performance Assessment Battery (UTC-PAB) II: Hardware/Software Specifications, 1987.

3. Walter Reed Performance Assessment Battery, March 1990.
   a. Hardware/software requirements
   b. Installation and configuration
   c. Procedure for running PAB
   d. PAB pre-run preparations
   e. Constructing or modifying a battery
   f. First PAB
   g. Data storage
   h. Data analysis

4. AGARD-STRES User's Manual, May 1989

5. The UTCPAB-AGARD STRES Battery: Manual and System Documentation
   a. Software installation
   b. Instruction files

c. Hardware / software requirements

d. Software documentation

    1. Setup file

        a. General information

        b. Procedure instructions

            1. Miscellaneous page

            2. Response keys page

            3. Task selection / ordering

        c. Possible errors

        d. Running instructions

    2. Menu file

        a. Instructions

        b. Procedure

        c. Possible errors

    3. Individual task and statistics descriptions

        a. Mathematical Processing

        b. Memory Recall

        c. Spatial Processing

        d. Reaction Time Task

        e. Unstable Tracking Task

        f. Grammatical Reasoning

        g. Dual Task (Unstable Tracking / Memory Search)

e. AGARD test technical descriptions

Appendix G: Test Instructions for the Practice Session

These are the instructions to be read to the subject when he is taking the performance tests for the first time (and made available in printed form thereafter). The instructions are combined from the AGARD-STRES, WRPAB, and UTC-PAB Manuals (36; 48; 56).

In the WRPAB, there is no difference in the screens if it is a practice session; instructions and a reminder of the appropriate response keys are always given. The AGARD-STRES, however, only provides instructions and response key designators in the practice session. The actual battery contains no instructions whatsoever. For that reason, these instructions need to be available for the subject before every battery.

Introduction

a. Tell the subject, "This is not an IQ test, but a number of short performance tasks to measure things like short term memory, reaction times, and your own assessments of how you feel at the moment. Please, remember to keep your fingers in contact with the keys throughout each task. Between each task you may remove your hand from the keyboard and flex it, etc. The reason for this is that we are interested in mental processing time but that can be masked or swamped by the longer time it takes to move your arm and hand through space. Please do not talk, eat, or drink during the tests themselves. Try to be as accurate and fast as possible. Both are being measured. Part of the batteries will get boring after awhile, but try to maintain the same motivation each time. This first session is a 'dry run' to familiarize you with what you will see on the screen, which keys to use, and what the rules are for each task" (48).

b. Remind the subject of his subject number and session number.

c. Ask if he has any questions.

d. Make sure the subject is in the practice portion of the tests

The Moodscale II Assessment

Point out that the first task, the Moodscale II, is an assessment of how he feels, not a test. There are 36 questions.

The Tests

a. Read the following instructions to the subject as he comes to each test in the battery. Give him a chance to read the instructions on the screen first. The origins of the instructions are listed after the title of the test.

b. Wilkinson Serial Reaction Time (48; 56:100): " A blinking '+' sign will be presented in one of the four quadrants of the CRT. The object of the task is to press the key on the keyboard that corresponds to the quadrant with the blinking sign. The blinking plus sign remains in a given quadrant until one of the four keys is pressed and then randomly appears in any one of the four quadrants, as which time you again press the corresponding key on the keyboard. Reaction times of all responses, correct and incorrect, are recorded. Do not look at your hands or you will miss the signal. Ignore the numbers on the keypad and just use the lower left four keys. There are 50 trials." **Subjects need to go through two sets of training trials (56:99).**

c. Manikin (48; 56:163): "This test examines your spatial ability. The man may be inside a circle or square but never both, as shown. He may be facing forward or backward, upright or upside down. "Matching stimulus' means if the man is in a circle, then pick the hand holding the circle. If the man is in a

square, then pick the hand holding the square. Use the same hand as if you were the Manikin. Put your thumbs against the spacebar, and all 8 fingers on keyboard even though you will only use your index fingers. Do not use the same hand to hit the keys, since the two hands differ in speed and we need to correct for that. Please work as quickly and as accurately as you can. Each block consists of 16 trials." **Subject should go through 64 trials** (56:162). Subject will see feedback each time as to whether the answer is correct.

d. Mathematical Processing (36:22; 56:74) "In this task, you must solve a number of simple addition and subtraction problems to determine whether the correct answer is less or greater than 5. The two possible responses are **i** for 'less than' or **j** for greater than'. No problem will ever have the value 5 as the correct answer. The problems appear one at a time on the screen, and should be solved from left to right. Each problem requires two operations (addition and/or subtraction). Always perform the additions and subtractions in the order that they appear in the problems. As soon as you respond to a problem, it will be erased and a new problem will appear shortly afterwards. Try to perform the task as quickly and accurately as possible. Go as fast as you can, but if you start to make errors because you are trying to go too fast, slow down. You should try to respond correctly to every problem. At the end of the testing period, the message 'end of block' will appear. The duration of each trial block is three minutes." **Subject needs to do at least two three-minute practice blocks** (36:21). This test gives feedback on the practice session.

e. Memory Search (36:29; 56:134) "This is a test of your ability to search your memory for particular letters. The task consists of two parts. You will be shown a set of letters to memorize, called the 'memory set'. It will contain either two or four letters, and you will be allowed to look at it for as long as you wish.

When you have memorized this set, you should press one of the response keys and you will then be shown a series of single test letter, one at a time. You have to decide whether each test letter is one of the letters in the memory set. If it is a member of the memory set, press **w**. If it is not, press **d**. Please try to respond as fast as you can without making any mistakes." **Subject should do at least two practice blocks** (36:28).

f. Memory Search / Unstable Tracking (36:46; 56:286-7) "You will now be required to perform concurrently two tasks: unstable tracking and memory search. You should use your preferred hand (the hand with which you normally write) to control the joystick, and your other hand to press the response keys. The two tasks are equally important, so try not to concentrate exclusively on one at the expense of the other.

In the tracking task, your objective is to keep a cursor centered on a target area in the middle of the monitor screen. You can control the movement of the cursor by moving the joystick. Moving the stick to the right moves the cursor to the right, and moving it to the left moves the cursor to the left. The cursor initially appears on the central target but tends to move horizontally away from this position. Try to keep it centered over the target at all times. If it reaches the boundary line, it will reappear at the target position and begin moving away again. This is called a control loss and should be avoided if possible.

While you are controlling the cursor, you will be required to respond to test letters in the memory search component of the task. As before, you will be shown a 'memory set' that will contain either two or four letter, and you will be allowed to look at it for as long as you wish. The tracking task will then begin immediately. After a few seconds, the memory set will disappear and you will be shown a series of single test letters. As before, you must decide whether each

test letter is one of the letters in the memory set. If it is a member of the memory set, press **w**. If it is not , press **d**. Please try to respond as fast as you can without making any mistakes." **Subjects should do at least two practice blocks** (36:46).

Appendix H: Instructions to the Subject for a Performance Testing Session

1. Now that you have had your vital signs checked and have reported your side effect symptoms, you are ready to take the performance testing batteries.

2. "This is not an IQ test, but a number of short performance tasks to measure things like short term memory, reaction times, and your own assessments of how you feel at the moment. Please, remember to keep your fingers in contact with the keys throughout each task. Between each task you may remove your hand from the keyboard and flex it, etc. Please do not talk, eat, or drink during the tests themselves. Try to be as accurate and fast as possible. Both are being measured" (48). Remember, the first task the Moodscale II, is an assessment of how you feel. It is not a test.

3. If you need to stop the battery before the tests have started, type **CTRL-C** or **CTRL-BREAK** to exit. To exit while the tests are executing, hold down the **ALT** key and type the letters **B R E A K**. To resume the program type **RUN** or press **F2**. Typing **GC . O 54321** will abort the session permanently. Type **SYSTEM** to exit BASICA (48).

4. Begin the battery.

   a. At the C : \ > prompt, type **cd wrpab.**

   b. At the C : \ WRPAB > prompt, type **basica**.

   c. At the OK prompt , press **F3**.

   d. At the LOAD" prompt , type **AFITPAB1"**.

   e. Press **Return**.

   f. At the OK prompt, press **F2**.

   g. Insert the data disk and press **Return**.

h. Type in your subject number.

Type in the session number.

Type in **0** for auto.

i. Follow the instructions on the screen.

j. The introductory screen for the Walter Reed Performance Assessment Battery should be on the screen.

5. Reread the instructions in your handout for Moodscale II, 4-Choice Serial Reaction Time, and Manikin.

6. Follow the instructions on the screen to take the tests.

7. To exit the WRPAB and proceed into the AGARD-STRES, type **SYSTEM.**

8. Reread the instructions in your handout for Mathematical Processing, Memory Search, and the Dual-Task. Remember, CTRL-C allows you to exit the battery if you need to.

a. At the C : \ WRPAB > prompt, type **CD\AGARD**.

b. At the C : \ AGARD > prompt, type **menu**.

c. The initial battery screen will show up, press **Return**.

d. At the General Information Screen, press **Return**.

e. At the Main Menu screen, type **1**.

f. At screen 2, press **Return** in answer to every question.

g. Type **Y** for the correct, incorrect prompts at the bottom of the screen.

h. At the next screen, type **EX** to exit.

9. Take the battery.

10. Battery returns to the Main Menu. Typing **EX** brings the C:> prompt back.

11. Prepare to ride the motion sickness chair.

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Vita

Captain Z. Nagin Ahmed [redacted] She graduated from Shawnee Mission East High School in Prairie Village, Kansas, during 1982. She attended Cornell University, where she earned her Bachelor of Science in Operations Research/Industrial Engineering and her Bachelor of Arts in Human Experimental Psychology. Upon graduation in 1986, she was commissioned a second lieutenant in the United States Air Force.

Captain Ahmed's first assignment on active duty was to the Aircrew Training Division, Directorate of Support Systems Engineering, Aeronautical Systems Division, Wright-Patterson AFB, Ohio. In May, 1989, she was assigned to the Space Operations program at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio.

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13. ABSTRACT (Maximum 200 words)

The Air Force Institute of Technology is conducting research into the effectiveness of certain drugs for controlling motion sickness. If the drugs are found to be useful, they must still be proven to have no harmful effects on the operator's performance abilities. The Unified Tri-Services Cognitive Performance Assessment Battery is a performance assessment method designed to be used by all the military branches. This will encourage testing standardization, data exchange, and method comparability. Five tests were chosen from the battery to form the basis of this drug performance testing. The tests are Four-Choice Serial Reaction Time, Visual Memory Search, Mathematical Processing, Manikin, and the Unstable Tracking/Memory Search Dual Task. The battery software/hardware is now in development, so until it is available, the tests will be implemented from the software of the Walter Reed Performance Assessment Battery and the Advisory Group for Aerospace Research and Development-Standardized Tests for Research With Environmental Stressors Battery.

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